

WHAT IS CLAIMED IS:

1. An optical transmission system, used for radio access for transmitting information between a center station and a subscriber terminal through a radio base station for transmitting and receiving a radio signal to and from an antenna portion, for optically
5 transmitting radio signals bidirectionally by respectively connecting a plurality of radio base stations covering different service areas and the center station through a plurality of optical fibers, wherein

said center station comprises at least

10 an electrical-optical conversion portion, receiving one or more baseband signals as one or more modulated electric signals each having a predetermined intermediate frequency, for converting the electric signals into optical signals by intensity modulation,

15 a local oscillation signal source for outputting a predetermined local oscillation signal,

an external modulation portion for intensity-modulating the optical signal obtained by the conversion in said electrical-optical conversion portion using the local oscillation signal outputted from said local oscillation signal source, and

20 an optical branching portion for branching the optical signal intensity-modulated by said external modulation portion, and respectively outputting optical signals obtained by the branching to the plurality of optical fibers, and

an optical branching portion for branching an optical signal obtained by the intensity modulation in said external modulation portion into optical signals whose number corresponds to the number of said plurality of radio base stations, and

20 a plurality of IF modulation portions, receiving one or more modulated electric signals each having a predetermined intermediate frequency by one or more baseband signals for each of said radio base stations to which the electric signal is to be transmitted, for respectively intensity-modulating the optical signals obtained by
25 the branching in said optical branching portion using the electric signals, and respectively outputting the modulated optical signals to the plurality of optical fibers, and

each of said plurality of radio base stations comprises at least an optical-electrical conversion portion for converting the optical
30 signal transmitted through said optical fiber into an electric signal in a radio frequency band, and feeding the electric signal to said antenna portion.

3. An optical transmission system, used for radio access for transmitting information between a center station and a subscriber terminal through a radio base station for transmitting and receiving a radio signal to and from an antenna portion, for optically
5 transmitting radio signals bidirectionally by respectively connecting a plurality of radio base stations covering different service areas and the center station through a plurality of optical

fibers, wherein

said center station comprises at least

10 an electrical-optical conversion portion, one or more
modulated electric signals each having a predetermined intermediate
frequency by receiving one or more baseband signals for converting
the electric signals into optical signals by intensity modulation,
a local oscillation signal source for outputting a
15 predetermined local oscillation signal,

a first external modulation portion for intensity-
modulating the optical signal obtained by the conversion in said
electrical-optical conversion portion using the local oscillation
signal outputted from said local oscillation signal source,

20 a first optical branching portion for branching the optical
signal intensity-modulated by said first external modulation portion,
and respectively outputting optical signals obtained by the branching
to a plurality of downstream optical fibers,

a plurality of first optical-electrical conversion
25 portions for respectively converting the optical signals transmitted
from said plurality of radio base stations through a plurality of
upstream optical fibers into electric signals in intermediate
frequency bands, and

a plurality of demodulation portions for respectively
30 demodulating the electric signals obtained by the conversion in said
plurality of first optical-electrical conversion portions to the
baseband signals, and

each of said plurality of radio base stations comprises at least

a second optical branching portion for branching the
 35 optical signal transmitted through said downstream optical fiber into
 two optical signals,

a second optical-electrical conversion portion for
 converting one of the optical signals obtained by the branching in
 said second optical branching portion into an electric signal in a
 40 radio frequency band,

a band pass filter for extracting only an electric signal
 component in a desired frequency band from the electric signal
 obtained by the conversion in said second optical-electrical
 conversion portion,

45 a circulator portion for outputting the electric signal
 component extracted by said band pass filter and the radio signal
 received by said antenna portion, respectively, to said antenna
 portion and a second external modulation portion, and

said second external modulation portion for intensity-
 50 modulating the other optical signal obtained by the branching in said
 second optical branching portion using the radio signal outputted
 from said circulator portion, and outputting the intensity-modulated
 optical signal to said upstream optical fiber.

4. An optical transmission system, used for radio access
 for transmitting information between a center station and a
 subscriber terminal through a radio base station for transmitting

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and receiving a radio signal to and from an antenna portion, for
5 optically transmitting radio signals bidirectionally by
respectively connecting a plurality of radio base stations
covering different service areas and the center station through
a plurality of optical fibers, wherein

said center station comprises at least

10 a light source for outputting predetermined light,
a local oscillation signal source for outputting a
predetermined local oscillation signal,

a first external modulation portion for intensity-
modulating the light outputted from said light source using the
15 local oscillation signal outputted from said local oscillation
signal source,

a first optical branching portion for branching an
optical signal obtained by the intensity modulation in said first
external modulation portion into optical signals whose number
20 corresponds to the number of said plurality of radio base stations,
and

a plurality of IF modulation portions, receiving one or
more modulated electric signals each having a predetermined
intermediate frequency by one or more baseband signals for each
25 of said radio base stations to which the electric signal is to
be transmitted, for respectively intensity-modulating the
optical signals obtained by the branching in said first optical
branching portion using the electric signals, and respectively

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outputting the modulated optical signals to the plurality of
30 downstream optical fibers,

a plurality of first optical-electrical conversion
portions for respectively converting the optical signals
transmitted from said plurality of radio base stations through
a plurality of upstream optical fibers into electric signals in
35 intermediate frequency bands, and

a plurality of demodulation portions for respectively
demodulating the electric signals obtained by the conversion in
said plurality of first optical-electrical conversion portions
to the baseband signals, and

40 each of said plurality of radio base stations comprises

a second optical branching portion for branching the
optical signal transmitted through said downstream optical fiber
into two optical signals,

a second optical-electrical conversion portion for
45 converting one of the optical signals obtained by the branching
in said second optical branching portion into an electric signal
in a radio frequency band,

a circulator portion for outputting the electric signal
obtained by the conversion in said second optical-electrical
50 conversion portion and the radio signal received by the said
antenna portion, respectively, to said antenna portion and a
second external modulation portion, and

said second external modulation portion for

8. The optical transmission system according to claim 1,
wherein

the optical signal outputted from said external modulation
portion is an optical single-sideband signal with a carrier and
5 a single-sideband component.

9. The optical transmission system according to claim 1,
wherein

a Mach-Zehnder type external modulator is used for said
external modulation portion, and a bias point in the external
5 modulator is set to a point at which light output power is the
minimum or maximum so that the optical signal is intensity-
modulated by a component which is twice the frequency of said local
oscillation signal.

10. The optical transmission system according to claim 1,
wherein

a semiconductor laser for converting an electric signal into
an optical signal through direct modulation is used for said
5 electrical-optical conversion portion.

11. The optical transmission system according to claim 10,
wherein

an optical fiber in which the wavelength of the optical
signal outputted from said electrical-optical conversion portion

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5 and the zero dispersion wavelength almost coincide with each other
is used for said optical fiber.

12. An optical transmission system, used for radio access for
transmitting information between a center station and a subscriber
terminal through a radio base station for transmitting and receiving
a radio signal to and from an antenna portion, for optically
5 transmitting radio signals bidirectionally by respectively
connecting first to n-th (n is an integer of not less than two) radio
base stations covering different service areas and the center station
through first to n-th upstream and downstream optical fibers
respectively provided so as to correspond to the radio base stations,
10 wherein

said center station comprises

first to n-th electrical-optical conversion portions for
respectively converting one or more signals each having a
predetermined intermediate frequency into first to n-th optical
15 signals having different wavelengths λ_{d1} to λ_{dn} uniquely
corresponding to said first to n-th radio base stations,

a wavelength multiplexing portion for multiplexing said
first to n-th optical signals obtained by the conversion,

a local oscillation signal source for outputting a local
20 oscillation signal having a predetermined frequency,

an optical modulation portion for intensity-modulating the
multiplexed optical signals outputted from said wavelength

multiplexing portion using said local oscillation signal, and

a wavelength separation portion for wavelength-separating
 25 the multiplexed optical signals intensity-modulated into first to
 n-th modulated optical signals having wavelengths λ_{d1} to λ_{dn} , and
 sending out the k-th ($k = 1$ to n) modulated optical signal to said
 k-th downstream optical fiber, and

said k-th radio base station comprises an optical-electrical
 30 conversion portion, receiving said k-th modulated optical signal
 having the wavelength λ_{dk} transmitted through said k-th downstream
 optical fiber, for converting the modulated optical signal into an
 electric signal in a radio frequency band, and outputting the electric
 signal.

13. An optical transmission system, used for radio access
 for transmitting information between a center station and a
 subscriber terminal through a radio base station for transmitting
 and receiving a radio signal to and from an antenna portion, for
 5 optically transmitting radio signals bidirectionally by
 respectively connecting first to n-th (n is an integer of not less
 than two) radio base stations covering different service areas
 and the center station through first to n-th upstream and
 downstream optical fibers respectively provided so as to
 10 correspond to the radio base stations, wherein

said center station comprises

first to n-th electrical-optical conversion portions

for respectively converting one or more signals each having a predetermined intermediate frequency into first to n-th downstream optical signals having different wavelengths λ_{d1} to λ_{dn} uniquely corresponding to said first to n-th radio base stations,

first to n-th upstream light sources respectively outputting first to n-th upstream optical signals having wavelengths λ_{u1} to λ_{un} which differ from any of the wavelengths λ_{d1} to λ_{dn} and differ from one another,

a wavelength multiplexing portion for multiplexing said first to n-th downstream optical signals obtained by the conversion and said outputted first to n-th upstream optical signals,

a local oscillation signal source for outputting a local oscillation signal having a predetermined frequency,

an optical modulation portion for intensity-modulating the multiplexed optical signals outputted from said wavelength multiplexing portion using said local oscillation signal,

a wavelength separation portion for wavelength-separating said multiplexed optical signals intensity-modulated to the first to n-th modulated downstream optical signals having the wavelengths λ_{d1} to λ_{dn} and the first to n-th modulated upstream optical signals having the wavelengths λ_{u1} to λ_{un} , and sending out the k-th ($k = 1$ to n) modulated downstream optical signal, together with the k-th modulated upstream optical signal,

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to said k-th downstream optical fiber, and

first to n-th optical-electrical conversion portions
40 for respectively converting the optical signals transmitted
through said first to n-th upstream optical fibers into electric
signals, and

said k-th radio base station comprises

a two-wavelength separation portion, receiving the
45 optical signal transmitted through said k-th downstream optical
fiber, for separating the optical signal into said k-th modulated
downstream optical signal having the wavelength λ_{dk} and said k-th
modulated upstream optical signal having the wavelength λ_{uk} ,

an optical-electrical conversion portion for converting
50 the k-th modulated downstream optical signal obtained by the
separation in said two-wavelength separation portion into an
electric signal and outputting the electric signal, and

an RF modulation portion for intensity-modulating the
k-th modulated upstream optical signal obtained by the separation
55 in said two-wavelength separation portion using the inputted
radio signal, and sending out the k-th modulated upstream optical
signal intensity-modulated to said k-th upstream optical fiber.

14. The optical transmission system according to claim 13,
wherein

the wavelengths λ_{d1} to λ_{dn} of said first to n-th downstream
optical signals are set so as to belong to a predetermined first

predetermined intermediate frequency into first to n-th
15 downstream optical signals having different wavelengths λ_{d1} to
 λ_{dn} belonging to a predetermined first wavelength band uniquely
corresponding to said first to n-th radio base stations,

first to n-th upstream light sources respectively
outputting first to n-th upstream optical signals having
20 wavelengths λ_{u1} to λ_{un} which differ from any of the wavelengths
 λ_{d1} to λ_{dn} and belong to a predetermined second wavelength band,

a wavelength multiplexing portion for multiplexing said
first to n-th downstream optical signals obtained by the
conversion and said outputted first to n-th upstream optical
25 signals,

a local oscillation signal source for outputting a local
oscillation signal having a predetermined frequency,

an optical modulation portion for intensity-modulating
the multiplexed optical signals outputted from said wavelength
30 multiplexing portion using said local oscillation signal,

a wavelength separation portion for wavelength-
separating said multiplexed optical signals intensity-modulated
to first to n-th modulated downstream optical signals having the
wavelengths λ_{d1} to λ_{dn} and the first to n-th modulated upstream
35 optical signals having the wavelengths λ_{u1} to λ_{un} , and sending
out the k-th ($k = 1$ to n) modulated downstream optical signal,
together with the k-th modulated upstream optical signal, to said
k-th downstream optical fiber, and

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first to n-th optical-electrical conversion portions
40 for respectively converting the optical signals transmitted
through said first to n-th upstream optical fibers into electric
signals, and

said k-th radio base station comprises an electro-
absorption type modulation portion, receiving the optical signal
45 transmitted through said k-th downstream optical fiber to
separate the optical signal into the k-th modulated downstream
optical signal having the wavelength λ_{dk} and said k-th modulated
upstream optical signal having the wavelength λ_{uk} , converting
said k-th modulated downstream optical signal in said first
50 wavelength band representing an optical-electrical conversion
function into an electric signal and outputting the electric
signal, and intensity-modulating said k-th modulated upstream
optical signal in said second wavelength band representing an
electrical-optical conversion function using the inputted radio
55 signal and sending out said k-th modulated upstream optical signal
intensity-modulated to said k-th upstream optical fiber.

16. The optical transmission system according to claim 13,
wherein

said first to n-th upstream light sources respectively output
said first to n-th upstream optical signals which uniquely correspond
5 to said first to n-th downstream optical signals and have wavelengths
 λ_{u1} to λ_{un} respectively different from the wavelengths λ_{d1} to λ_{dn}

of the first to n-th downward optical signals by predetermined amounts fs.

17. A high frequency optical transmitter used in a center station, connected to a plurality of radio base stations respectively covering different service areas using a plurality of optical fibers, for optically transmitting radio signals,

5 comprising

a three-branching portion for branching an inputted electric signal into first and second electric signals which are the same in phase and a third electric signal which has a phase difference of 90° from the first and second electric signals;

10 an electrical-optical conversion portion for converting said third electric signal into a light intensity modulated signal;

a first delay control portion for adjusting the propagation time of said first electric signal;

15 a second delay control portion for adjusting the propagation time of said second electric signal;

a two-branching portion for branching an inputted local oscillation signal into first and second local oscillation signals which are opposite in phase;

20 a third delay control portion for adjusting the propagation time of said first local oscillation signal;

a fourth delay control portion for adjusting the

propagation time of said second local oscillation signal;

25 a first multiplexing portion for multiplexing said first
electric signal outputted from said first delay control portion
and said first local oscillation signal outputted from said third
delay control portion;

a second multiplexing portion for multiplexing said second electric signal outputted from said second delay control portion and said second local oscillation signal outputted from said 30 fourth delay control portion; and

a differential intensity modulator, having first and second electrodes, for modulating said light-intensity modulated signal outputted from said electrical-optical conversion portion by
35 respectively inputting signals obtained by the multiplexing in said first and second multiplexing portions to said first and second electrodes,

said first to fourth delay control portions being adjusted such that said first and second electric signals inputted to said first and second electrodes of said differential intensity modulator through said first and second multiplexing portions are the same in phase, to subject the optical signal outputted from said electrical-optical conversion portion to phase modulation and subject the optical signal to optical modulation which is the same in amount as and is opposite in phase to the frequency deviation (an FM index) of a light frequency modulation component of the optical signal.

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18. A high frequency optical transmitter used in a center station, connected to a plurality of radio base stations respectively covering different service areas using a plurality of optical fibers, for optically transmitting radio signals, comprising

5 a three-branching portion for branching an inputted electric signal into first and second electric signals which are the same in phase and a third electric signal which has a phase difference of 90° from the first and second electric signals;

an electrical-optical conversion portion for converting said
10 third electric signal into a light intensity modulated signal;

a first delay control portion for adjusting the propagation time of said first electric signal;

a second delay control portion for adjusting the propagation time of said second electric signal;

15 a two-branching portion for branching an inputted local oscillation signal into first and second local oscillation signals which have a difference of 90° to each other;

a third delay control portion for adjusting the propagation time of said first local oscillation signal;

20 a fourth delay control portion for adjusting the propagation time of said second local oscillation signal;

a first multiplexing portion for multiplexing said first electric signal outputted from said first delay control portion and said first local oscillation signal outputted from said third delay
25 control portion;

a second multiplexing portion for multiplexing said second electric signal outputted from said second delay control portion and said second local oscillation signal outputted from said fourth delay control portion; and

30 a differential intensity modulator, having first and second
electrodes, for modulating said light intensity modulated signal
outputted from said electrical-optical conversion portion by
respectively inputting signals obtained by the multiplexing in said
first and second multiplexing portions to said first and second
35 electrodes,

said first and second delay control portions being adjusted such that a phase difference between said first and second electric signals inputted to said first and second electrodes of said differential intensity modulator through said first and second
40 multiplexing portions is zero, to subject the optical signal outputted from said electrical-optical conversion portion to phase modulation and subject the optical signal to optical modulation which is the same in amount as and is opposite in phase to the frequency deviation of a light frequency modulation component of the optical
45 signal,

said third and fourth delay control portions being adjusted such that said first and second local oscillation signals inputted to said first and second electrodes of said differential intensity modulator through said first and second multiplexing portions have a difference of 90° to each other, to subject said optical signal

to optical side-band modulation with a light carrier.

19. A high frequency optical transmitter used in a center station, connected to a plurality of radio base stations respectively covering different service areas using a plurality of optical fibers, for optically transmitting radio signals, comprising:

5 a two-branching portion for branching an inputted electric signal into first and second electric signals which have a difference of 90° to each other;

 an electrical-optical conversion portion for converting said first electric signal into a light intensity modulated signal;

10 a delay control portion for adjusting the propagation time of said second electric signal; and

 an integrated modulation portion, comprising a phase modulation portion and an intensity modulation portion formed on the same substrate, for modulating said light intensity modulated signal
15 outputted from said electrical-optical conversion portion by inputting said second electric signal outputted from said delay control portion to the phase modulation portion and inputting an inputted local oscillation signal to the intensity modulation portion,

20 in said phase modulation portion, the optical signal outputted from said electrical-optical conversion portion being subjected to phase modulation and subjected to optical modulation which is opposite in phase to the frequency deviation of a light frequency

modulation component of the optical signal.

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